equalization portion of the receiver as opposed to MLSE decoding. Support for the claim amendment "in a receiver" can be found in FIGURE 1 as well as p. 8, lns. 1-11. Support for the claim amendment "nonlinear" can be found in equation 6, at p. 9, ln. 6, and at pg. 10, lns. 1-11. Moreover, it is well known in the art that MLSE, when used in an equalization context, is a nonlinear equalization technique. Lastly, support for the claim amendment "hypothesized" can be found at pg. 10, lns. 21-28.

In the previous office action, the Examiner stated in the "***Response To Arguments***" section that "[A]pplicant's assertions that branch metrics in Kumar are not applied to a receiver and an MLSE equalizer are incorrect." This is a clear misinterpretation of Kumar on the part of the Examiner. The Examiner cited col. 33,lines 24-30 and Figures 9 and 14a to rebut applicant's assertions. In doing so, however, the Examiner has mis-characterized the Kumar reference.

One of the misunderstandings is the difference between MLSE equalization (used to handle distortion introduced by the radio channel) and MLSE decoding (used to decode a forward error correcting code applied at the transmitter). Kumar, col. 33, lines 24-30 clearly refers to the need to "decode" in the context of convolutional codes. Thus, the "sequence" that Kumar is estimating is the information bit sequence, using the equalized received symbols. By contrast, the present invention estimates the "sequence" of transmitted symbols, performing the equalization process. The claims of the present invention clearly indicate that the context of the present invention is an equalizer.

Regarding Figures 9 and 14A, Figure 9 clearly shows an equalizer (209). The actions of deinterleaving and bit estimation occur **after** equalization. Thus, the Viterbi decoder in Figure 14A, which occurs **after** bit estimation and deinterleaving, is **not** the equalizer, but rather the convolutional decoder. Therefore, the branch metrics discussed in Kumar do **not** apply to the equalizer as asserted by the Examiner. There is no MLSE equalization in Kumar, just MLSE decoding which is an entirely different procedure.

Still referring to the ***Response to Arguments*** section of the last office action, the Examiner refers to Fig. 9 and filters 204 and 209. Filter 204 is an analog filter used in the process of converting the RF signal to baseband. Filter 209 is the equalizer, used to demodulate the symbols transmitted. In col. 58 of Kumar, this equalizer is described as compensating for the RF propagation channel (an equalizer, not a decoder). It is a FIR or IIR filter with adaptive filter taps. A decision feedback equalizer may also be. Starting at col. 58, line 40, Kumar indicates that channel estimation may be performed as part of equalization yet no details are given. Applicant, in his expertise, interprets this as performing channel estimates, then determining equalizer weights from those for linear or DFE equalization. Both linear and DFE are filtering approaches, in that they filter the received signal to produce bit estimates. DFE includes a feedback filter, which filters previous symbol decisions as well.

It is true that filtering involves convolving the signal with a set of coefficients. It is also true that an adaptive equalizer starts with an initial set of coefficients. However, these coefficients are filter weights, not hypothesized

symbols. With linear equalization (Kumar), there is no consideration given to different hypothesized symbol values. The filter output is used to produce a single detected symbol value. A linear equalizer does not "precompute" an output, it "computes" an output. It also updates the equalizer weights. In the present invention, precompute means more than compute. Precompute means computing a quantity, storing it, and using it multiple times to form branch metrics efficiently. This is different from Kumar's computing equalizer weights, storing them, and using them multiple times to form symbol estimates.

Yet another mischaracterization of the Kumar reference involves mixing operations that occur in the transmitter portion of a system and the receiver portion of a system. The present invention only describes operations in an equalizer in a receiver. The Examiner, however, has cited a part of Kumar that describes operations in a modulator in a transmitter. Specifically, Kumar col. 43, lns. 43-45 refers to an IFFT, which is part of signal generators 47 and 49. These appear in Figure 4, which is clearly a transmitter, as it starts with a source message and ends with a power amplifier and transmit antenna. In col. 32, the description of drawings indicates that Fig. 4 is "an IBOC DAB transmitter." As Fig. 9 is an "IBOC DAB receiver" and block 209 of Fig. 9 is an equalizer, it is clear that equalization is performed at the receiver, not the transmitter.

In addition, convolution (filtering) does not necessarily imply a "look-up" table. The fact that memory is needed to store intermediate results does not mean that those intermediate results will be used again in another computation.

Due to Applicant's belief that the Kumar reference has been mis-characterized by the Examiner, Applicants respectfully request reconsideration and withdrawal of the 35 USC 102(e) rejections of claims 1-2, 4-7, 9-10, and 12-13 based on the Kumar reference. Similarly, Applicants further request reconsideration and withdrawal of the 35 USC 103(a) rejections of claims 3, 8, and 11 in which Kumar is cited as the primary reference in the rejection.

CONCLUSION

For the reasons set forth above, the applicants believe the claims of the present application are in condition for allowance, which action is respectfully requested.

However, if the applicants have failed to adequately respond to any of the Examiner's objections or requirements or if the Examiner intends to finally reject the application, the applicants invite the Examiner's telephone communication of that fact to the applicants' attorney, Mr. Gregory Stephens at 919-286-8000 so that an interview can be arranged to resolve any discrepancy.

Respectfully submitted,
For the applicants,

Date: Nov. 20, 2002

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Claim Amendments in Bracket Underline Form

1. (Twice Amended) <u>In a receiver, a</u> [A] method for determining a branch metric in a <u>nonlinear</u> maximum-likelihood sequence-estimation equalizer which receives at least one antenna signal modulated with M-ary modulation, said method comprising the steps of:

pre-computing values equal to a product of a complex number and a [hypothetical] <u>hypothesized</u> symbol value;

storing said pre-computed values in a product look-up table;

adding select pre-computed values from said product look-up table to produce a result; and

determining said branch metric using said result.

4. (Twice Amended) <u>In a receiver, a</u> [A] filter in a <u>nonlinear</u> maximum-likelihood-sequence-estimation equalizer, which demodulates at least one received radio signal modulated with M-ary modulation, for producing a hypothesized received signal sample to be used for determining a branch metric, said filter comprising:

a memory for storing a product look-up table having pre-computed values equal to a product of a channel tap estimate and a [hypothetical] <u>hypothesized</u> symbol value for different iterations; and

an adder for adding select entries from the product look-up table to produce a hypothesized received sample signal.

5. (Amended) In a receiver, a [A] filter in a nonlinear maximum likelihood-sequence-estimation (MLSE) equalizer for M-ary modulation, said filter comprising:

means for pre-computing a plurality of possible values to be used in determining a branch metric;

a memory for storing said plurality of pre-computed possible values; and

means for combining select pre-computed values from said memory.

9. (Amended) In a receiver, a [A] method for computing a branch metric in a nonlinear maximum likelihood-sequence-estimation (MLSE) equalizer which demodulates M-ary modulated signals, said method comprising the steps of:

pre-computing a plurality of possible values to be used in the branch metric computation;

storing said plurality of pre-computed possible values in a memory;

adding select pre-computed values from said memory; and

computing said branch metric using said added select pre-computed values.

13. (Twice Amended) In a receiver, a [A] method for computing a branch metric in a multi-channel nonlinear maximum likelihood-sequence-estimation

(MLSE) equalizer which demodulates M-ary modulated signals, said method comprising the steps of:

pre-computing a plurality of possible values for each channel in said multi-channel MLSE to be used in the branch metric computation;

storing said plurality of possible values for each channel in separate product look-up tables; adding select values from said separate product look-up tables; and

computing said branch metric using said added select values.